AMERICAN MUSEUM NOVITATES

Number 433 Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City Oct. 14, 1930

59.57, 99 (78)

ROCKY MOUNTAIN BEES. I

BY T. D. A. COCKERELL AND BEULAH HIX BLAIR

1.—INTRODUCTION

BY T. D. A. COCKERELL

The undetermined Rocky Mountain bees belonging to The American Museum of Natural History have been loaned to the University of Colorado and will be discussed in a series of papers under the above general title. This very large collection was nearly all obtained by the expeditions conducted by Dr. F. E. Lutz a number of years ago, and is from numerous localities in Colorado, as well as some in Wyoming and other states. Some portions of it have already been recorded and described (e.g., in Novitates Nos. 23, 24, 40, 47, 226, 252). It is not very probable that the whole collection can be adequately dealt with in the near future. The enormous series of *Halictus*, for example, really requires the whole time of a competent student for many months. Doubtlessly, certain species are represented by hundreds of specimens, but each specimen has to be very critically examined, by one familiar with the group, in order to be determined. Nevertheless, it is expected that progress can be made, and many interesting facts brought to light. Every effort will be made to determine facts of general biological interest, or of significance in relation to broad problems of taxonomy and geographical distribution. For this reason it will be undesirable to restrict the discussions entirely to Rocky Mountain bees, since the interesting features of these can best be understood by comparison with those of their relatives in other regions. Certain types of investigation are especially desirable, in the present state of our knowledge.

(1). Biological observations, concerning nesting habits, natural enemies, parasites, mating of sexes, flowers visited, time of flight, altitudinal distribution, etc. Most of this must be done in the field but, as Mr. Chas. H. Hicks demonstrated, it is possible to bring the nests, and particularly hollow stems of herbaceous plants, into the laboratory, and have insects hatching during the winter months. This type of work presents almost endless opportunities, but it should be critically and analytically discussed. Both in biology and morphology, it is easily possible to be too verbose, and cover pages

with details which, at least as presented, have no clear significance. In every case we must ask (*a*) What is it? (*b*) Why is it? (*c*) What are the consequences?

(2). Morphological observations, concerning the structure of the mouth-parts, the venation, the genitalia, the abdominal sternites, the legs, etc. By such means we may reach adequate definitions of the families, tribes, genera, subgenera, species, subspecies and races. It cannot be taken as an axiom that forms with identical genitalia must be conspecific, but the presumption is that they are at least very closely allied. The genital structures are so complex that they are not likely to be repeated in different lines of descent. In the case of the mouth-parts, there are certainly parallel developments, as in the lengthening of the parts and the reduction in numbers of palpal joints, in quite different families. The advancement or specialization of the parts is not uniform, and a species with highly differentiated mouth-parts may have primitive features in the venation, or the venation may be relatively specialized while the tongue and palpi remain little modified from the supposed ancestral type. These facts, as in the Mammalia, greatly aid in the construction of a system which represents the actual phylogeny of the insects. In the vertebrate series, the teeth on the one hand, and the paired appendages on the other, show independent modifications, and using these together we may go far toward the establishment of a genuinely valid system of classification.

(3). Taxonomic investigations, based on the above. In the accurate definition and limitation of genera and higher groups, it is not at all desirable to consider only a single fauna. This method of work has impaired the validity of many of the conclusions reached by Robertson in Illinois, in spite of the fact that his skill and diligence have been truly remarkable. The question, how many genera should we recognize, remains in a manner insoluble, or necessarily dependent largely on conventions, which differ at different times and in different groups. It is a generally acceptable postulate, that the members of a genus must have had a common ancestor possessing the generic characters. That is, the genus must not be polyphyletic. As a consequence of this, if we consider the loss of an intercubital nervure in the *Andrena* group a generic character, several groups allied to *Andrena* but with only two cubital cells must be treated as distinct genera. They are manifestly derived, by parallel modification, from different groups of *Andrena*. At the same time, except for the venational character, in which they agree, they belong to *Andrena*. It is probable that such groups as these would be better treated as subgenera, in spite of the desire to dismember, if possible, such a large genus as *Andrena*.

Among the larger genera, we greatly need exact studies which will enable us to define natural groups or subgenera. In the absence of such groupings, authors describe numerous species without any reference to the structural peculiarities which indicate their group-positions. Thus, the arrangement of the species tends to become chaotic and unnatural, much as it used to be in the snail genus called *Helix*, until

Pilsbry took it in hand. Unquestionably, we shall have to define and name many more subgenera, but I have been inclined to proceed slowly with this work, in the absence of sufficient morphological studies to place it on a firm foundation.

The problem of subspecies or races among bees is becoming very interesting. Its proper elucidation requires good series from many diverse localities. By the term subspecies I understand a group of individuals inhabiting a particular region, having in common, or at least normally, certain peculiarities by which they may be distinguished, yet without marked structural characters. When a species has split into two or more subspecies, we conventionally retain the original specific name for the race first described and designate the others by special subspecific names. For the purposes of nomenclature, we are not required to state which is actually the oldest form. This is really unavoidable, yet it may be misleading. Thus, in the Palæarctic fauna, most of the wide-ranging species were first described from Europe. Subspecies inhabit Siberia, Japan and other countries. We naturally tend to imagine that in all these cases the European species spread eastward, and gradually became modified as we find them. Yet, for anything we know to the contrary, the real origin may have been in Asia.

It is commonly said that subspecies are recognized by the fact of intergrading with the species. My conception is that they arise under conditions of isolation, for various reasons, and when it happens that they spread, so that the ranges of two races meet, hybrids are formed.[1] Can we use this appearance of hybrids as a means of distinguishing species from subspecies? If so, it would appear to lead us to an illogical position. We should have to say that A became differentiated from B and was a true species, until their ranges met, when the appearance of intermediates reduced it to subspecific rank. I have myself argued in the past that insular races must be treated as species because, in the nature of the case, hybridisation does not take place and intermediates are not found. Yet such races may differ only in very minor characters, and I now concede that they may better deserve subspecific rank.

The subspecies is an incipient species, and no one can, in his practical work as a taxonomist, definitely determine the appropriate category in all cases. Yet with experience I believe it is commonly possible to reach reasonable conclusions, and in very many cases specific validity cannot be questioned. The structural characters, as those of the genitalia, are decisive when marked differences are found.

[1]An admirable discussion of subspecies (unfortunately called varieties) appears in Kinsey's 'Gall Wasp genus *Cynips*,' received since the above was written. All students of Hymenoptera should read this work.

Mutations among the bees are not as generally recognized by name as among Lepidoptera. It is principally in *Bombus* that we find marked variants, apparently exhibiting Mendelian inheritance. They are inconstant and likely to be heterozygous. Yet we may suppose that from time to time they become the dominant and eventually the sole type in a region, and then attain subspecific rank. It is well known among Lepidoptera that a form may be racial in one locality and appear only as an aberration in another.

Some of the particular problems needing study in our region are the following:

(1). We have evidence of the intrusion of the fauna of the Mississippi Valley in the eastern part of Colorado and of Pacific-coast elements in Utah and parts of Colorado and Wyoming. In New Mexico a southern element (e.g., *Centris*) appears and even spreads north into Colorado to some extent (e.g., *Exomalopsis*). Collecting in special regions, for the elucidation of these matters, is very desirable.

(2). It is really scandalous that we know nothing of the host relations of our very numerous species of *Nomada*. We also need studies of our other parasitic bees. Why are the epeolines so extremely numerous with us?

(3). Although so many species of *Osmia* have been described, there are many of which we know only one sex. Biological observations are greatly needed to associate the sexes. The genitalia have been studied and figured by Miss Sandhouse, but her work has not yet been published.

As this is written in the hope that it may be useful to future students, I venture to add some suggestions for a beginner.

Those who begin to collect insects commonly desire more than anything else to get them identified. This is natural and reasonable, since the names make it possible to find out what is known concerning the species. Among the bees, however, it is hardly profitable to begin this way. Our bee-fauna as a whole is still very imperfectly known, and the best treatment now possible would be extremely inadequate, except in the case of *Bombus* and a few of the small genera. The specific characters of bees are often very subtle, and we are constantly discovering characters previously overlooked. The student is thus likely to make very superficial and largely worthless determinations, or give the matter up and appeal to a specialist. But the specialist, except in a few genera, cannot name the species offhand and does not feel justified in putting aside his own work to conduct researches for another, who sometimes even expects to describe the new species which have been worked out for him. If this sounds rather unsympathetic, let it be said that the possession of a named set of bees does not ensure accuracy of determina-

tions or precision of knowledge if the student does not know his bees; even access to the types will not save him from numerous errors.

A better mode of approach is to collect diligently, making full notes on habits and time of flight, and then go to work to classify the species, setting forth their characters in dichotomous keys, until they are well known and understood. After all my years of labor, I still begin by making keys when handling a new lot of material, leaving the question of names temporarily out of account. When the species are thus understood, it is remarkable how much more intelligible the literature becomes, even poor descriptions usually containing significant expressions. When all this has been done, and every effort has been made to determine the species and find out their relationships, it is then entirely proper to appeal to the specialist (if one can be found) to do those things which he alone, with his greater experience and large collection, can do.

No doubt the best work for the beginner, aside from observations in the field, is in morphology. It requires years to become a competent taxonomist, and involves the gathering of a large library and collection. But morphological studies can be made by any clever and diligent person who has good eyes and knows how to draw. Even the drawing may not be necessary, if photographic methods can be used. Such morphological studies, especially when done under advice, will reveal new or little-known structures, will assist in the determination of species, and will in many ways aid in classification, though their utilization requires the guidance of an experienced person.

The study of wild bees is an excellent occupation for the amateur, who can carry it on through many years. It takes him into the wilds, and gives him healthy exercise, not without excitement, during the summer.[1] When the bees are not flying, he has his collection to study, and he must be a poor collector if he cannot get enough in a summer to occupy all his spare time during the winter. In the present state of the science, he has the certainty of many discoveries. Large and handsome species, quite unknown to science, may still be found even in the United States. He is indeed at a disadvantage, in so far as there is no complete manual to which he may refer; but there is the compensating satisfaction of knowing that he is contributing to a future manual, in the pages of which his name will have an honorable place.

Bees are especially noteworthy for their interesting habits, and some very able workers prefer to concentrate on this phase of the subject,

[1]As an example of what we may term the dramatic aspects of bee collecting, Mr. P. H. Timberlake had collected about 340 species of bees at Riverside, California, but had never found *Bombomelecta*. On April 4, 1930, he took two species of *Bombomelecta* in less than two minutes!

having little opportunity, and often little inclination, to enter the taxonomic field. Taxonomists should be glad to render assistance to such as these; Pérez doubtless felt it a high honor to thus assist Fabre. In other orders of insects, the aid given by Poulton to workers in the tropics has made possible the publication of many valuable contributions to biology. The student of behavior may well depend on the taxonomist for the names of his insects, but eventually he makes a return, inasmuch as his observations contribute to our understanding of families, genera and species.

Students of geographical distribution, without being specialists in the study of bees, can make good use of records in their statistical work. It is hardly to be expected that any one will work up a collection solely for this purpose, but it is at any rate a useful by-product of taxonomic work. In my own case, having studied the bees of the regions I have visited, I find every record of a species belonging to some other group of interest, as confirming or modifying the opinions I have reached concerning the origin and nature of the biota.

Finally, there is still another group of enthusiasts, by no means to be despised. These are the collectors, pure and simple. In some cases they are specialists in the taxonomy of another group, but they are not necessarily specialists at all. We need many more collectors, to penetrate into regions yet untrod by those interested in bees. It is easy to point out many localities which are sure to yield rich returns, and the apparatus and training required make no great demands on purse or time. Such collectors should not expect complete reports, in a short time, on their discoveries. They must understand that one may catch in a few days specimens which require weeks, possibly months, of study.[1] It is discouraging to be told that the few bees obtained by Darwin on the famous voyage of the 'Beagle' have not yet been identified. It sometimes appears that the donation of collections to Museums is like throwing them into a bottomless pit.[2] But it rarely pays to collect all sorts of things at random; it is better to find out before hand what can be studied and reported on. When, as is often the case, the taxonomist cannot deal

[1]As an illustration of what is easily possible I may cite the collection made at Victoria, Mexico, by Barber and Holloway on March 16, 1922. I presume it represents only part of their day's work. The series collected include three new species; two other species new to Mexico; five previously known from Mexico, but now first recorded from a definite locality; and three species known from definite localities in Mexico, but new to the State of Tamaulipas. Many similar instances could be reported.

[2]There is one difficulty which confronts museum curators but is little understood by collectors who wonder why their specimens are not readily identified. In all large collections (especially the largest) there are many species incorrectly named, or in the wrong genus. Former curators made mistakes, and specimens have come in from many sources, determined by various people. It is utterly impossible to check up all these determinations, short of doing revisional work on the groups to which the species belong. Thus, a reliable report on a collection is a much more serious undertaking than may at first appear.

with the whole collection, he can at least report on its more interesting aspects, and show an appreciative and sympathetic attitude. I remember vividly my delight, when a very young man, on being told that I had found a variety of snail new to the British Islands; and I am not yet too old to feel a thrill of pleasure on learning that a species sent in is new to the British Museum or some other large public collection, or entirely new to science. An official letter of thanks, no matter how courteously worded, is nothing compared with the least item showing that one has actually been the means of adding to scientific knowledge.

2.—*NOMIA BAKERI* CONSIDERED A SUBSPECIES OF *NOMIA NEVADENSIS*

By Beulah Hix Blair

Externally, *Nomia nevadensis* Cresson and *Nomia bakeri* Cockerell appear to be two distinct species. *N. bakeri* is nearly two millimeters longer than *N. nevadensis* and is more robust. *N. nevadensis* has a yellowish-red abdomen, whereas *N. bakeri* has a black abdomen. The mesothorax of *N. nevadensis* has coarser punctures and the tubercles are not so red as in *N. bakeri*.

Because of these external differences it was a surprise that the genitalia were identical, since the genitalia of *Nomia* have such definite specific characters. The genitalia of *N. nevadensis* and *N. bakeri* (Fig. 1) differ from those of other groups of *Nomia*. The stipites are simple in comparison. The apical portions of the dorsal flanges and ventral flanges are pointed.

The *N. nortoni* group (*N. nortoni*, *N. californica*) has broad dorsal flanges which bend at right angles over the dorsal side of the posterior ends of the sagittæ (Fig. 2). The Australian group of *N. australica* and *N. flavoviridis* has stipites which are very broad, but do not bend.

Small chitinous structures on the apical portion of the stipites are important for the determination of the species. *N. bakeri* and *N. nevadensis* have just a few of these. They are pointed. The *N. nortoni* group has hooked structures which have a fringe arrangement along the ends of the stipites. The Australian species, *N. australica* and *N. flavoviridis*, have numerous hooked structures, whereas the European species, *N. diversipes* and *N. ruficornis*, have ball-like structures.

The ventral plates are alike in *N. nevadensis* and *N. bakeri*. The fifth ventral plate occupies a normal position, but in the *N. nortoni* group this plate extends over the sixth ventral plate, entirely covering it.

In the *N. nevadensis* group there are two large tubercles at the posterior edge of this plate (Fig. 3). The tips of these tubercles extend outward and are covered with hairs. The *N. nortoni* group (Fig. 4) has two groups of plume-like hairs anterior to which are chitinous plates placed at right angles with this plate. The sixth ventral plate of the *N. nevadensis* group is exposed, bearing plumose hairs along the posterior edge (Fig. 5). The *N. nortoni* group has this plate without hairs (Fig. 6).

The seventh ventral plate is a ribbon-like structure curved on the posterior edge like an arch. The *N. nevadensis* group has just one pair of lobes, which look like the ends of the arches, on the posterior edge (Fig. 7). The *N. nortoni* group has two pairs of lobes (Fig. 8). In both groups these lobes bear long hairs. The species of the *N. nortoni* group are easily distinguished by the difference in the size of the plate. *N. nevadensis* and *N. bakeri* have plates of the same size.

The eighth ventral plate is the same in *N. nevadensis* and *N. bakeri* (Fig. 9). The snout-like structure, posteriorly directed, found on this plate is very sharply pointed in the *N. nevadensis* group. The *N. nortoni* group has a notch on the end of the snout (Fig. 10). The end is flat rather than pointed. The foreign groups lack a snout on this plate.

There are other similarities found in *N. nevadensis* and *N. bakeri*. The *N. nevadensis* legs are of lighter color, but they have the same size and shape. The tibiæ which have distinct individual chacteristics in this genus are exactly alike. The anterior wings of both measure nine millimeters, and the venation is identical. The color of the antennæ is the same.

One-fourth of the females of *N. bakeri* examined have the first two segments of the abdomen red. This shows that there are variations within the species.

N. nevadensis lives in the arid southwest, from New Mexico through Nevada, while *N. bakeri* represents it in the eastern foothill region of Colorado.

In view of all these facts we must conclude that *N. bakeri* is a subspecies of *N. nevadensis*, to be known as *N. nevadensis bakeri*.

Specimens from The American Museum of Natural History:

84; *N. bakeri;* ♀; Canfield, Boulder, La Junta, Colo.; F. E. Lutz.
2; *N. bakeri;* ♂; Canfied,Boulder, La Junta, Colo.; F. E. Lutz.
1; *N. nevadensis;* ♀; Las Cruces, N. M.; T. D. A. Cockerell.

From Professor Cockerell's collection:

2; *N. nevadensis;* ♂; Mesilla Park, N. M.; T. D. A. Cockerell.

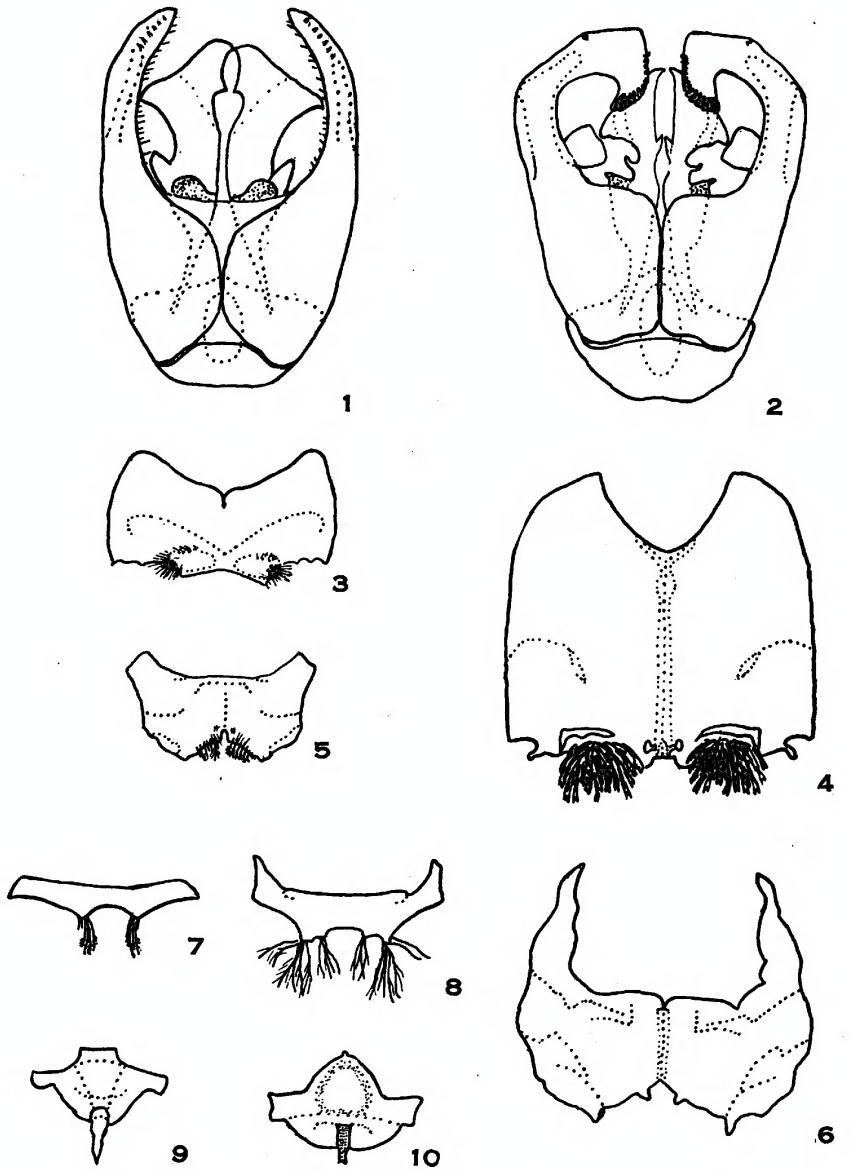


Fig. 1. Genitalia of *Nomia nevadensis* group. Fig. 2. Genitalia of *N. californica*

Figs. 3–10. Ventral plates: 3, fifth, *N. nevadensis* group; 4, fifth, *N. californica;* 5, sixth, *N. nevadensis* group; 6, sixth, *N. californica;* 7, seventh, *N. nevadensis* group; 8, seventh, *N. californica;* 9, eighth, *N. nevadensis* group; 10, eighth, *N. californica.*

All of the ventral plates have the same magnification. The genitalia of *N. nevadensis* (Fig. 1) have three times the magnification of the ventral plates. Figure 2 has one and one-half times the magnification of the ventral plates. In reality the genitalia in Fig. 1 are one-half the size of the genitalia in Fig. 2. A camera lucida was used.

3.—THE GENUS *NOMIA*

By T. D. A. Cockerell

The collection from the American Museum includes six species of *Nomia* and one of *Dieunomia*, the latter being best considered a subgenus.

Dieunomia Cockerell

Nomia (Dieunomia) mesillæ (Cockerell)

A male and a female collected by Dr. F. E. Lutz at Boulder, Colorado, 5500 ft. alt., June 30, 1922, at *Petalostemon*.

The species was described from the male (Entomologist, XXXII, 1899, p. 266). The female differs in the usual sexual characters, and also has the scape red at base, the second antennal joint red; the hair on mesothorax (especially anteriorly) and postscutellum strongly suffused with fulvous; the wings smoky throughout (darkest apically) though not dark fuliginous; the short anterior tibiæ red with the apex blackened; the middle and hind tibiæ also mainly red, the hind tibiæ with a pale yellowish scopa, but black hair along hind margin; the tarsi (especially the hind ones) more or less rufescent. The abdominal hair-bands are very distinct, and the venter has stiff bright ferruginous hair. The hind margin of the first tergite is conspicuously red.

The *Dieunomia* females before me may be tabulated as follows:

1.—Hair on under side of abdomen black or gray; abdomen with or without conspicuous hair-bands.....2.

Hair on under side of abdomen pale fulvous or red.....3.

2.—Tegulæ dark; hair of mesothorax seal-brown (Rockyford, Colo.; Gillette). *marginipennis* (Cresson).

Tegulæ pale reddish; hair on mesothorax clear rufofulvous (Victoria, Texas, at *Helianthus;* A. J. Leister).....*apacha* (Cresson).

3.—Tegulæ dark; tibiæ black (Aztec, New Mexico; C. E. Mead). *xerophila* (Cockerell).

Tegulæ translucent rufofulvous; tibiæ mainly red (Boulder, Colo.; F. E. Lutz). *mesillæ* (Cockerell).

Nomia Latreille

The type of *Nomia* is not *N. diversipes* Latreille, as I formerly supposed, but the Indian *N. curvipes* (Fabricius). This is an insect which would be placed in *Paranomia* Friese, in the broad sense, but actually there is a good deal of difference. I possess a male *N. curvipes* from F. Smith's collection. I have no typical *N. chalybeata* Smith (the type species of *Paranomia*),[1] but I have a couple of male *N. pavonura* Cock-

[1]Designated by Cockerell (1910). Friese's other three *Paranomia* are two of them *Hoplonomia*, and one (*opposita* Smith) proves to be *Halictus*.

erell, collected in the Foochow district, China (C. R. Kellogg). This *N. pavonura* is a southern representative of *N. chalybeata*, and was originally described from Formosa, the type of *N. chalybeata* coming from Shanghai. There is so little difference, aside from color, that *N. pavonura* may well rank as a subspecies. The flagellum is black, and the legs also are black, with the hind tibial lobe yellow and a pallid mark on the hind basitarsi. Bingham says the legs of *N. chalybeata* are rufofulvous, but Smith does not. In the males of *N. curvipes* and *N. pavonura* the antennæ are ordinary, not narrowed and sharply pointed as in our American group of *N. nortoni* Cresson.

The following descriptions contrast the two types.

(1). *Nomia curvipes*, male (*Nomia, s. str.*).—Clypeus not carinate; stigma small, truncate, not extending far into marginal cell; third cubital cell about as broad on marginal as second; area of metathorax small, granular, dull, with no channel; hind femora extremely thick, with a strong tooth below; fourth sternite deeply and broadly emarginate.

(2). *Nomia pavonura*, male (*Paranomia*).—Clypeus longitudinally carinate; stigma rather large, pointed, extending well into marginal cell; third cubital cell about or nearly twice as broad as second on marginal; area of metathorax with a shining transverse channel; hind femora thick but without a tooth beneath; fourth sternite not thus emarginate. The tongue is very long and slender.

On this basis, we have one American species which can be associated with true *Nomia*, at least by the broadly emarginate fourth sternite, the appearance of the metathorax, and more or less on the venation. But it has two long spines on the postscutellum, and therefore should go in Ashmead's Asiatic genus or subgenus *Hoplonomia*. This species is *N. expulsa* Cockerell, labelled "Guyane, Maroni." Although I fail to identify it with any Asiatic species, I cannot help suspecting that the label is erroneous, and that it really came from some where in tropical Asia.

Our various green-banded North American forms are clearly to be placed with the *Paranomia* series, and can by no means be referred to *Nomia* proper, or to *Hoplonomia*. They can be divided into two subgenera, **Acunomia**, new subgenus, in which the male antennæ are slender and sharply pointed at the apex (type, *N. nortoni* Cresson) and *Paranomia*, in which the antennæ are not thus modified. If we regard *Paranomia* as a genus, then *Acunomia* will stand under it as a subgenus.

ACUNOMIA Cockerell

The large and handsome *Nomia nortoni* Cresson is well known. I have it from Mexico, New Mexico, and Nebraska. West of the Rockies its place is taken by another, smaller type, diverse aspects of which have

been named *melanderi* Cockerell, *californica* Cockerell, *acus* Cockerell, and *paysoni* Cockerell. The long series obtained by Dr. Lutz is referred to *N. californica*, and is from the following localities:

Yellowstone Park; July 20, 1920; ♂, ♀.
Provo, Utah; July 28–29, 1920; ♂, ♀.
Rifle, Colorado; July 19–21, 1919; ♂, ♀; at alfalfa and sunflower.
Palisades, Colorado; July 18–19, 1919; ♂, ♀; at alfalfa.
Fruita, Colorado; July 16, 1919; ♂, ♀; at *Melilotus alba.*
Grand Junction, Colorado; July 17–19, 1919–Aug. 3, 1920; ♂, ♀; at alfalfa and *Melilotus alba.*
Glenwood Springs, Colorado; July 29, 1919; ♀.

The females have a green band on first tergite and are *N. californica.* The males lack this band and are *N. acus*, except for the dark tegulæ. The types of *californica* and *acus* were both labelled "Southern California." I conclude that *acus* is the male of *californica*, presenting some variation, but not separable as a race. I also conclude that *paysoni*, based on a male from Naturita, Colorado, is no more than a variation of *californica.*

N. melanderi, described from the state of Washington, is the prior name of this series. This northern form lacks the green band on first tergite in both sexes, though in the female green can be seen at the sides of the tergite. *N. californica* lacks this band in the male (i.e., *acus*). But in Lower California (Proc. Calif. Acad. Sci., XII, 1923, p. 102) both sexes have the green band. This form I now designate *N. californica* **peninsularis**, new subspecies, the type from Las Animas Bay (Van Duzee). It should be stated that sometimes the bands fail to color up properly, and in such cases the banding normal to the race may not be clearly evident.

N. melanderi is at present little known, and I treat *N. californica* as a species. But I have little doubt that more collecting in the Pacific states will show that there is only one valid specific unit, *N. melanderi*, the other forms taking subspecific rank.

PARANOMIA Friese

These insects, with ordinary antennæ in the male, have proved rather difficult to classify, and more knowledge of some of the species is greatly needed. In the collection of the American Museum I find two old specimens, male and female, collected Sept. 30, 1899, at Uvalde, Texas (J. L. Zabriskie Collection). They were presented by Professor H. F. Wickham. They unfortunately lack the antennæ, but they clearly represent different species, both differing from anything described. They are accordingly described herewith.

Nomia uvaldensis, new species

FEMALE.—Length, about 9.5 mm.; black, with broad, very pale reddish (slightly suffused with green) bands on tergites 2 to 4; no trace of a band on first tergite, but margin at sides with dense white hair; head broad, face with dull white hair; clypeus with a strong median keel; sides of front dull and excessively minutely sculptured; upper border of prothorax, tubercles, and postscutellum with much white hair; mesothorax finely and closely punctured, with thin white hair, the posterior disc with thin inconspicuous black hair; scutellum shining but well punctured, the punctures of two sizes, median depression weak; mesopleura dull, with much long white hair; tegulæ chestnut-red, with white hair anteriorly; wings hyaline, faintly dusky on apical margin; stigma ferruginous, obtuse, but projecting well into marginal cell; nervures dusky reddish; basal nervure falling distinctly short of nervulus; second cubital cell receiving recurrent nervure slightly beyond middle; third cubital long, but not very much longer than second on margnial; legs more or less rufous, the hind femora beneath, and their tibiæ and tarsi, distinctly red; hair of legs white, the scopa on hind tibiæ all white; a fulvous brush at end of hind basitarsus; abdomen dullish, very finely punctured, the first tergite dull, with distinct though fine and weak punctures; fifth tergite with very dark brown hair, white at sides; venter with white hair.

Uvalde, Texas.

From *N. mesillensis* this is readily known by the dull first tergite, and much narrower, differently colored abdominal bands. Also, the disc of mesothorax is much more closely and finely punctured. From *N. foxii* (*moctezumæ*) it is known by the absence of distinct punctures on the basal part of the second tergite, the shorter stigma, and the red tegulæ. From *N. maneei* by the quite differently colored abdominal bands, the first broader, the longer and much paler stigma, and the channel at base of metathorax granular, without cross-ridges. From *N. fedorensis* it is known by the quite differently colored abdominal bands, the lack of strong punctures on the first two tergites, and the red tegulæ. The darker, dusky-margined stigma and quite different abdominal bands show that it cannot be the male of *N. zabriskii.*

Nomia zabriskii Cockerell and Blair, new species

MALE.—Length, a little over 9 mm.; black, similar to *N. tetrazonata* Cockerell, with narrow green abdominal bands (none on first tergite), that on fourth extremely brilliant. It is perhaps to be regarded as a subspecies of *N. tetrazonata*, but it differs thus: hind femora not so stout; hind tibiæ broader; hind tarsi paler; wings paler, stigma lighter, being very pale straw-yellow; anterior middle of mesothorax duller and more closely punctured; first tergite with punctures well separated in middle above; fourth tergite more finely and closely punctured, less shining.

Uvalde, Texas.

In *N. tetrazonata* the second and third sternites are much more thickly covered with white hair. *N. zabriskii* agrees with *N. tetrazonata*

and differs from *N. mesillensis* by the narrower abdominal bands, the narrower hind tarsi, and the hind tibiæ excavated in front before middle. The abdominal structures are described by Mrs. Blair in the next section.

Nomia universitatis Cockerell

FEMALE.—Boulder, Colorado; June 30, 1922. MALE.—Colorado Springs, Colorado: Sept. 15, 1896 (H. F. Wickham).

So far as I am at present able to determine, *N. moctezumæ* Crawford is identical with *N. foxii* Dalla Torre (*punctata* Fox); but Fox's "variety" of *N. punctata* is *N. universitatis*.

Nomia howardi Crawford

Based on a single female, about 9 mm. long, from San José de Guaymas, Mexico (L. O. Howard). *N. howardi vanduzeei* Cockerell was based on a female, 10 mm. long, from Loreto, Lower California (Van Duzee). I noted of the latter that it was much smaller than *N. californica*, the abdominal bands much paler, the second to fourth not nearly so broad, the antennæ differently colored (flagellum bright ferruginous beneath), tegulæ redder, and base of second tergite with larger punctures. As the male is unknown, and I have at present no material of either *howardi* or *vanduzeei*, the position of this species in the classification remains somewhat ambiguous, though it is certainly valid.

EPINOMIA Ashmead

There appears to be no sufficient reason why the group of *Nomia nevadensis* Cresson should not be merged in *Epinomia*, though the type of the latter (*N. triangulifera* Vachal) is very distinct. It is evident that the ancestors of *Epinomia* reached America quite independently of the *Paranomia* series.

The group of *Nomia nevadensis* presents a series of forms, in different parts of the country, so closely related that they may well be considered of subspecific rank. These are as follows:

N. nevadensis Cresson.—From Nevada to New Mexico, in the latter state going as far North as Santa Fé.

N. bakeri Cockerell.—Described from Fort Collins, Colorado, and widely distributed in that state east of the mountains. It was taken by Lutz at Boulder, White Rocks, Canfield and La Junta, the dates being July 30 to Aug. 15. Variety **rufibasis**, new variety, has the first two tergites, or sometimes only the first, red. It was taken at Boulder, Aug. 7–12, 1919 (Lutz), occurring commonly with ordinary *N. bakeri*. There is a smaller specimen from La Junta, Aug. 12, 1920 (Lutz), but it also occurs with ordinary *N. bakeri*. Whether the *nevadensis* and *bakeri* forms meet anywhere between La Junta and Santa Fé is not known; but

should they do so, they might be expected to hybridize, as Mrs. Blair has shown that the genitalia are quite the same.

N. pattoni Cockerell.—Mississippi, Alabama and Texas.

N. arizonensis Cockerell.—Arizona. The female differs from the others of the series by the short, strongly fluted area of metathorax, and has the best claims to be regarded as a separate species.

N. angelesia Cockerell.—California. Concerning this and the latter, see Pan-Pacific Entomologist, 1925, p. 179.

The following key will facilitate the determination of American *Nomia*.

1.—Margins of tergites (often excepting first) with light tegumentary color-bands, usually green....2.
Margins of tergites without such bands....22.
2.—Males....3.
Females....13.
3.—Anterior wing about 13 mm.; first tergite densely punctured dorsally, without a green band; tergites 2–5 with emerald green bands; antennæ slender and sharply pointed at end....*nortoni* Cresson.
Anterior wing much shorter....4.
4.—Antennæ at apex elongate and sharply pointed; abdomen with green bands..5.
Antennæ ordinary, not sharply pointed at apex....8.
5.—First tergite with an entire green band; bands flushed with vermilion (Lower (California)....*californica peninsularis* Cockerell.
First tergite without a green band....6.
6.—Flagellum more robust; abdominal bands suffused with lilac.
melanderi Cockerell.
Flagellum less robust....7.
7.—Bands very bright green....*californica* Cockerell (*acus* Cockerell).
Bands yellowish green, flushed with orange..*californica* var. *paysoni* (Cockerell).
8.—Hind tibiæ reddish, excessively produced on inner side; bands (on tergites 2–5) pale, only very slightly greenish; tegulæ large....*expulsa* Cockerell.
Hind tibiæ otherwise; species smaller....9.
9.—Hind tibiæ black, without an apical, pale lobe; bands (on tergites 2–5) flushed with blue; flagellum bright ferruginous beneath (Texas).
fedorensis Cockerell.
Hind tibiæ with a pallid lobe or lateral extension....10.
10.—Hind femora and tibiæ clear red; wings yellowish (Cuba)..*robinsoni* Cresson.
(*N. wickhami* Ashmead occurs in the Bahamas, and has much more black on tibiæ. See Proc. U. S. Nat. Mus., XXXVIII, 1910, p. 297, for details.)
Hind femora and tibiæ dark brown or nearly black, except tibial lobe....11.
11.—Flagellum clear ferruginous beneath; abdominal bands narrow (Arizona).
tetrazonata Cockerell.
(For the related *N. zabriskii*, see above. *N. maneei* Cockerell is easily separated from *N. tetrazonata* by the much less robust hind femora.)
Flagellum dark, obscurely reddish beneath....12.

12.—Hind femora hardly swollen; abdomen very coarsely punctured. *universitatis* Cockerell.

Hind femora greatly swollen; abdomen less coarsely punctured. *mesillensis* Cockerell.

(If flagellum rather strongly red beneath (some *mesillenis*), distinguished from *tetrazonata* by larger size and much broader abdominal bands).

13.—Anterior wings about 12.3 mm.; no band on first tergite.....14.

Anterior wings much shorter.....15.

14.—Bands green; wings strongly reddened.....*nortoni* Cresson.

Bands ferruginous; wings hyaline with broad dusky margin. *nortoni plebeia* Cockerell.

15.—First tergite with a green band.....16.

First tergite with no green band.....17.

16.—Larger; hair of thorax anteriorly pale fulvous or white (the latter from Riverside, Calif., at *Polygonum lapathifolium;* Timberlake). *californica* Cockerell.

Smaller (for particulars see above).....*howardi* Crawford.

17.—First tergite dorsally smooth and impunctate.....*mesillensis* Cockerell.

First tergite dorsally evidently punctured.....18.

18.—Bands extremely brilliant green, the third flushed with purple; flagellum bright ferruginous beneath.....*fedorensis* Cockerell.

Bands not thus brilliant; flagellum dark or dusky reddish beneath.....19.

(If flagellum lighter beneath (*maneei*), distinguished from *fedorensis* by the lighter tegulæ and much more weakly punctured first tergite.)

19.—Larger; first tergite conspicuously elevated before the apical depression; second also with a smooth swelling before the depression; extreme sides of first tergite showing green.....*melanderi* Cockerell.

Smaller; first two tergites not thus modified.....20.

20.—Larger, punctures of abdomen very large and coarse; wings very dark. *universitatis* Cockerell.

Smaller; punctures of abdomen small or weak.....21.

21.—Disc of third tergite with conspicuous punctures (New Mexico). *foxii* Dalla Torre (*moctezumæ* Crawford).

Disc of third tergite with excessively minute dense punctures (North Carolina). *maneei* Cockerell.

Disc of third tergite impunctate in middle, with conspicuous punctures at sides; middle of second tergite basally hardly at all punctured (with conspicuous punctures in *foxii*).....*waldensis* Cockerell.

22.—Abdomen wholly or mainly red.....*nevadensis* Cresson.

Abdomen wholly or mainly black.....23.

23.—Legs at least mainly red.....24.

Legs dark.....25.

24.—Larger.....*nevadensis bakerii* Cockerell.

Smaller and more finely punctured.....*nevadensis pattoni* Cockerell.

25.—Larger; anterior wing about 10 mm.....26.

Much smaller.....27.

26.—Wings orange, with dusky apical region; tegulæ clear rufotestaceous (Texas). *bolliana* Cockerell.

Wings hyaline, little dusky; tegulæ darker; second recurrent nervure more remote from outer intercubitus than first from second intercubitus (the reverse is true of *bolliana*).....*triangulifera* Vachal.

27.—Flagellum of male ferruginous beneath, the color abruptly contrasting with the black, which occupies two-thirds of the circumference.
nevadensis arizonensis Cockerell.

Flagellum of male very dark reddish beneath, the red shading into the black (as in typical *nevadensis*).....*nevadensis angelesia* Cockerell.

(In the female, *arizonensis* differs from others of the *nevadensis* group by the short, strongly fluted area of metathorax.)

In the above table, I have purposely used such expressions as "larger" and "smaller," without giving the actual dimensions. The student is invited to consult the original descriptions for these. Tables are extremely useful aids to taxonomy, but we must deplore a common tendency to use them alone, without taking the trouble to read the descriptions. The most the table can do is to create a strong presumption of identity, when we are dealing with a fauna which is only partly known.

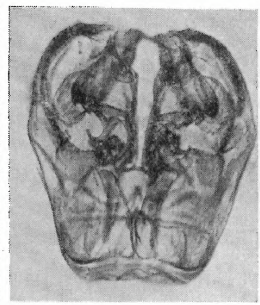
4.—ABDOMINAL STRUCTURES OF *NOMIA ZABRISKII*

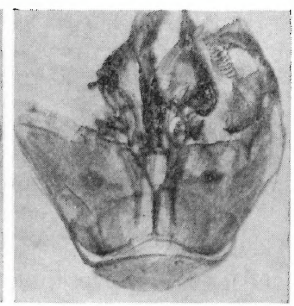
By Beulah Hix Blair

Nomia zabriskii Cockerell and Blair belongs to the same group as *N. nortoni* Cresson, *N. californica* Cockerell, and *N. universitatis* Cockerell. The male genital armatures are similar in shape. The apical portions of the dorsal flange of the stipites are wide and reach beyond the sagittæ. They bend at right angles over the dorsal side of the ends of the sagittæ. The ventral and median flanges are present in these four species.

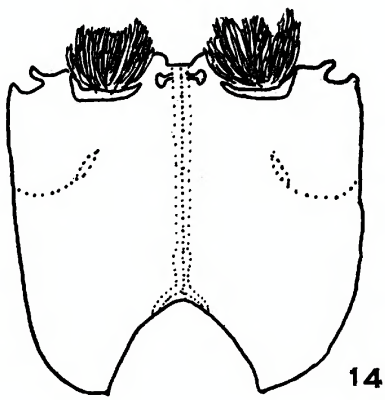
All of these species have small chitinous structures on the apical portion of the dorsal flange. They are arranged as a fringe. *N. nortoni*, *N. californica* (Fig. 11) and *N. universitatis* (Fig. 12) have these fringe structures at the end of the stipites on that region bent forward over the dorsal side of the sagittæ. *N. universitatis* has fewer and shorter structures than have *N. nortoni* and *N. californica*. *N. zabriskii* (Fig. 13) has the fringe-like structures attached at the side of the bent portion—that side away from the sagittæ. The structures point towards the sagittæ lying across the surface of this region of the apical portion. *N. zabriskii* has short blunt structures on the inner surface of the stipites opposite the widest region of the sagittæ.

All four of these species have sharply pointed structures on the outer side at the very posterior tip of the apical portion of the stipites. About six are arranged in a line. They are placed closely together.

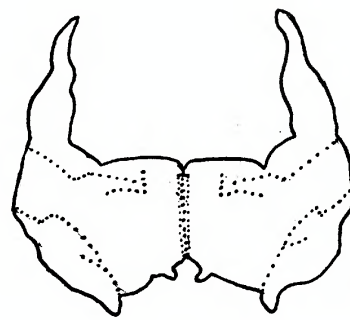




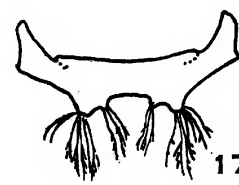
11 12 13



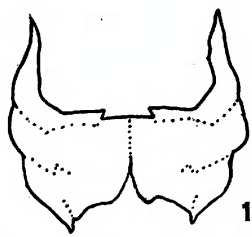
14



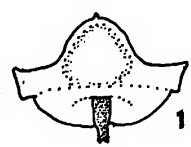
15



17



16



19

18

Figs. 11 to 13. Genitalia of *Nomia*. 11, *N. californica;* 12, *N. universitatis;* 13, *N. zabriskii*.

Figs. 14 to 19. Ventral plates: 14, fifth ventral plate of *N. californica;* 15, sixth ventral plate of *N. californica;* 16, sixth ventral plate of *N. zabriskii;* 17, seventh ventral plate of *N. californica;* 18, seventh ventral plate of *N. zabriskii;* 19, eighth ventral plate of *N. californica*.

For the drawings, a camera lucida was used. The magnification is the same for all of the ventral plates.

Of other *Nomias* that I have examined, none have the bent apical portions of the dorsal flange; not all of them have the median flange; and none have the fringe-like arrangement of the structures.

The ventral plates of *N. nortoni*, *N. californica*, and *N. zabriskii* are alike except in size. The sixth ventral plate of *N. nortoni* is 4 mm. wide, that of *N. californica* 3 mm. wide, and that of *N. zabriskii* 2 mm. wide. The other ventral plates have the same proportion.

The fifth ventral plate of these species cover the sixth ventral plate (Fig. 14). On the posterior edge of the fifth plate are two groups of thick hairs arranged as plumes. They are very conspicuous. The hairs are split at the ends. Those near the median line have a bulge from which several branches spring.

Anterior to each group of hairs is a sheetlike, chitinous structure placed at a right angle with the plate. On the median line, almost between the groups of hairs, are two very narrow, long, chitinous structures extending downward at a right angle to the plate.

The sixth ventral plates (Figs. 15 and 16) are alike in structure. They are bent in a manner which probably bears some relation to the organs within.

The seventh ventral plates of these species have two pairs of lobes on the posterior edge (Figs. 17 and 18). Long plumose hairs extend from each lobe or point. Some of the *Nomia* that I have examined have but one pair of lobes.

The snout-like projection on the eighth ventral plate has a notch (Fig. 19). This is not true of some of the other *Nomia* that I have studied.